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DEVELOPMENT OF ULTRA-THIN FILM PRESERVATIVE COMPOUNDS

Preparedunder Navy, Bureau of Naval Weapons
Contract NOw 61-0855

Quarterly Report No. 2

1 October 1961 through 31 January 1962

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FOSTER D. SNELL, INC.
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ABSTRACT

Construction of the controlled cyclic condensation humidity cabinet was completed. Some delay was encountered by the necessity of design changes and repair of leaks to the refrigeration systems.

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PLATES

I. INTRODUCTION. OPERATIVE PRINCIPLES OF EQUIPMENT

In this controlled cyclic condensation humidity cabinet, corrosion test specimens are exposed to alternating conditions of condensation and evaporation of moisture from the test surfaces. Raising the mean temperature and, to some extent, increasing the frequency of this artificial diurnal cycle is intended to produce accelerated corrosion processes which correspond closely to corrosion processes actually encountered by metal parts in storage.

To accomplish the cycle of condensation-evaporation, air containing a fixed percentage of water is continuously supplied to a compartment in which the test panels are exposed. Since the percentage of moisture in the air is constant, variations in temperature result in variations of relative humidity In order to effect condensation of water on the test specimens, it is not necessary to lower the temperature of the air in the entire cabinet; it is only necessary to lower the temperature of that part of the environment in closest proximity to the test surface. This localized cooling is accomplished by mounting specimens over a water jacket containing refrigeration tubing. By periodic on-off operation of the refrigeration system, a repeatable pattern of condensation and evaporation of moisture is obtained.

For our equipment, moisture content and air temperature are controlled by the following operation: Air from the compressed air line is passed through a sintered bronze filter to remove oil and water. The pressure is

next reduced from 100 psi. to 10 psi. and the air is led through a larger Fiberglas filter to remove all traces of water, oil, and dirt that may have escaped the first filtering. From the second filter, the air is bubbled through a heated distilled water bath in order to dissolve the proper amount of water vapor required by the test conditions. The amount of moisture dissolved in the air is fixed by controlling the rate of air flow, water level, and water temperature in the moisturizing chamber. Air, now containing a proper percentage of water vapor, is then passedthrough a long coil suspended in a heated oil bath. This is merely to preheat the air somewhat so that it will be easier to maintain the air temperature at the proper level in the humidity cabinet. Air is distributed in the cabinet above and below the specimen holders through perforated copper tubing and is heated by thermostatically controlled heaters. The condensation-evaporation cycle obtained on the test panels is determined by the on-off operation cycle of the compressor, which is controlled by a programming clock.

II. COMPONENT PARTS OF CONTROLLED CYCLIC CONDENSATION HUMIDITY CABINET

In this section are listed the essential parts that are necessary in the construction and operation of the controlled cyclic condensation humidity cabinet.

Code	Part	Description	Purpose
A	Needle valve	--	Shut-off valve for compressed air-line
B	Filter, sintered bronze	--	Remove water and oil from air
C	Pressure regulator	--	Reduce air-line pressure to suitable level
D	Filter, Fiberglas	Sealed 5-gallon drum filled with Fiberglas	Remove any oil, water, or dirt from air not removed by "B"
E	Flowrater	Flowmeter tube and valve	Control rate of air-flow through moisture chamber
F	Moisture chamber	5-gallon sealed drum with heated distilled water bath	To saturate air with water vapor
G	Heat exchanger	Copper coil in 5-gallon heated oil bath	Preheat and "dry" water vapor-saturated air
H	Air distribution manifold	Perforated copper tubing shaped in conjoined square and circle	To distribute air in humidity cabinet
I	Cabinet	Cubic, copper-sheeted box with 4 windowed doors and see-through Plexiglas cover	Contain test specimens, test atmosphere, and auxillary equipment necessary for maintaining desired conditions.

Code	Part	Description	Purpose
J	Compressor	1/2 h.p. hermetically sealed refrigeration compressor	To enable cooling of specimens
K	Programmer	24-hour electric clock with on-off plugs	To control on-off operation of compressor
L	Moisture filter	Silica gel cartridge	To remove any vapor from refrigerant to prevent valve freeze-ups, etc.
M	Needle valves (2)	--	To isolate refrigeration manifold and return line from compressor
N	Expansion valve	--	Allow expansion of liquid refrigerant to gas
O	Manifold	1/2" copper tubing joined through T-valves	For distribution of coolant to water-jacket trays
P	Bleeder	Needle valve at end of manifold	To bleed manifold of excess refrigerant, oil; to draw vacuum, etc.
Q	Specimen trays	Stainless steel water jackets with 3/8" copper coil, with cut-out holes for mounting specimens.	To mount test specimens
R	Return line	Same as manifold	To return refrigerant gas for recirculation
		AUXILIARY PARTS	
D_1	Relief tube	3/8" open-ended, vertical, S-shaped copper tube filled with 10" column of mercury	Prevent air pressure buildup in system

Code	Part	Description	Purpose
E_1	Flowmeter	--	See "E"
E_2	Needle valve	--	See "E"
F_1	Water tank	5-gallon distilled water bottle with necessary tubing	To supply water to m ture chamber
F_2	Float valve	Small valve with float-actuated handle connected to F_1 with 3/8" copper tubing	To control water leve moisture chamber
F_3	Distributor	3/8" copper tubing with closed end and perforated sides beneath water level, leading from E_2	To bubble air through moisture chamber
F_4	Heating system	(a) Immersion heater (b) Relay (c) Thermostat (d) Thermometer (e) Pilot light	To control temperatu water in moisture ch
G_1	Copper coil	50-foot coil of 1/2" copper tubing	Conduct air through l exchanger
G_2	Heating system	Same as F_4	Control temperature heat exchanger
I_1	Heating	Same as F_4 and G_2 except two heaters are used	To heat air in cabine desired temperature
I_2	Doors	20" x 20" hinged, Plexiglas, windowed (18" x 18") catch-locked doors	Observation; access cabinet
I_3	Cover	30" x 30" double-layer Plexiglas lid	To enclose test while mitting observation c

Code	Part	Description	Purpose
E_1	Flowmeter	--	See "E"
E_2	Needle valve	--	See "E"
F_1	Water tank	5-gallon distilled water bottle with necessary tubing	To supply water to moisture chamber
F_2	Float valve	Small valve with float-actuated handle connected to F_1 with 3/8" copper tubing	To control water level in moisture chamber
F_3	Distributor	3/8" copper tubing with closed end and perforated sides beneath water level, leading from E_2	To bubble air through moisture chamber
F_4	Heating system	(a) Immersion heater (b) Relay (c) Thermostat (d) Thermometer (e) Pilot light	To control temperature of water in moisture chamber
G_1	Copper coil	50-foot coil of 1/2" copper tubing	Conduct air through heat exchanger
G_2	Heating system	Same as F_4	Control temperature in heat exchanger
I_1	Heating	Same as F_4 and G_2 except two heaters are used	To heat air in cabinet to desired temperature
I_2	Doors	20" x 20" hinged, Plexiglas, windowed (18" x 18") catch-locked doors	Observation; access to cabinet
I_3	Cover	30" x 30" double-layer Plexiglas lid	To enclose test while permitting observation of test

Code	Part	Description	Purpose
J_1	Pressure gauge	--	For use with compressor
L_1	Sight glass	--	For use with moisture filter; indicates amount of moisture present and amount of refrigerant in system
Q_1	Connecting tubing	3/8" flare nut-fitted copper tubing	To connect water jackets with manifold (M) and return line (R)
Q_2	Rubber gaskets (2 each)	--	To prevent metal to metal contact between specimen and tray.
Q_3	Hold-down plate	Cut-out aluminum plate fitted over specimen tray	To seal specimens against water in water-jacket

III. CHANGES IN CONSTRUCTION OF CONTROLLED CYCLIC CONDENSATION HUMIDITY CABINET

For purposes of convenience, the component parts of the controlled cyclic condensation humidity cabinet are grouped under one of three classifications. These classifications are:

(1) Air Distribution and Moisture Control System
(2) Cabinet
(3) Refrigeration and Specimen Holder Systems

Included in the Air Distribution and Moisture Control System are the following component parts: (These parts have been lettered in accordance with the sequence of operations.)

A - Needle valve
B - Sintered bronze filter
C - Pressure regulator
D - Fiberglas filter
E - Flowrater
F - Moisture chamber
G - Heat exchanger
H - Air distribution manifold

The Refrigeration and Specimen Mounting System is composed of the following parts: (These, as with the air distribution and humidity control system, are lettered in accordance with the sequence of operation)

J - Compressor
K - Programmer
L - Moisture filter
M - Needle valves
N - Expansion valve
O - Manifold
P - Bleeder
Q - Specimens trays
R - Return line

The cabinet (I) houses the air distribution manifold (H) of the Air Distribution & Humidity Control System and the expansion valve (N), manifold (O), bleeder (P), specimen trays (Q), and return line (R) of the Refrigeration

and Specimen Mounting System.

In general, the systems and component parts of our Controlled Cyclic Condensation Humidity Cabinet correspond rather closely in function and construction with those in the equipment constructed by Minuti at Naval Air Material Center Laboratories, Philadelphia, Pennsylvania.

In the Air Distribution and Humidity Control System, the upper section of the air distribution manifold (H) has been enlarged in order to accommodate the different design of the specimen trays (Q). The cabinet is constructed as the original cabinet. However, in the Refrigeration & Specimen-Mounting System, several changes have been made. The specimen trays (Q) have been redesigned to accommodate ten 2" x 4" test specimens each, whereas the original specimen trays could accommodate only one 6" x 6" test specimen. In the original equipment, nine specimen trays (6" x 6" specimens in rows of 3 each) were contained in the cabinet, while in our equipment, there are 5 specimen trays (ten 2" x 4" specimens) inside the cabinet. These new trays are supported by two aluminum bars anchored to the side walls of the cabinet. The manifold and return line construction was necessarily modified to conform to the new specimen tray arrangement. T-valves are used to connect specimen tray refrigeration coils with the manifold and return lines because they offer a greater variety of control of the refrigeration cycle than was possible in the previous arrangement. The bleeder valve (P) and needle valves (M) were included in the system so that the specimen trays could be more easily isolated from the compressor when repairs are necessary, or samples are changed.

The plates included in this report illustrate some of the changes discussed above.

IV. SUMMARY

The completion of the controlled cyclic condensation humidity cabinet was delayed because of some necessary design changes and repairs to the refrigeration system. The changes effected are of a minor character and will not affect the basic operation of the cabinet. Primarily, the changes enable greater numbers of samples to be tested during any time period.

V. FUTURE WORK

With completion of the Controlled Cyclic Condensation Humidity Cabinet, testing of materials can now proceed.

Respectfully submitted,

FOSTER D. SNELL, INC.

William Miglas

William Miglas
Research Chemist

Bernard Berkeley

Bernard Berkeley, Director
Product Development Dept.

WM:BB:RF/oz. 16
Attached: 7 plates

CONTROLLED CYCLIC CONDENSATION HUMIDITY CABINET

Top View of Moisture Chamber (F)

Scale: 1/2" = 1"

F_1	Water feed tank	(not shown)	F_{4c}	Thermostat	
F_2	Float valve		F_{4d}	Thermometer	
F_3	Air Distributor		F_{4e}	Pilot light	(not shown)
F_{4a}	Immersion heater		E	Flowrater	(not shown)
F_{4b}	Relay	(not shown)	G	Heat exchanger	(not shown)

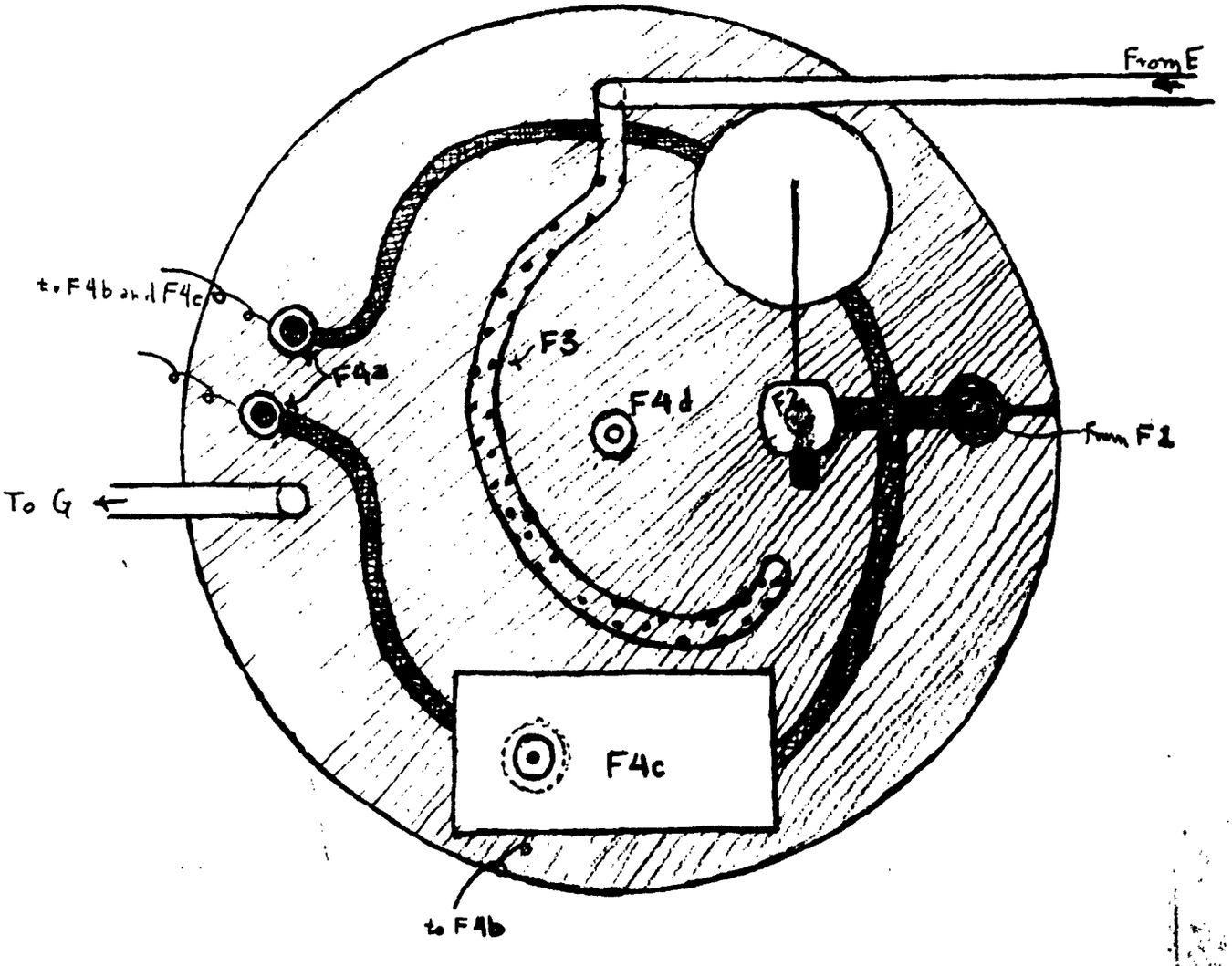


Plate #1

CONTROLLED CYCLIC CONDENSATION HUMIDITY CABINET

Side view of Moisture Chamber (F) **Scale: 1/2" = 1"**

F-1	Water feed tank (not shown)	F-4c	Thermostat
F-2	Float valve	F-4d	Thermometer
F-3	Air distributor	F-4e	Pilot light (not shown)
F-4a	Immersion heater	E	Flowrater (not shown)
F-4b	Relay (not shown)	G	Heat exchanger (not shown)

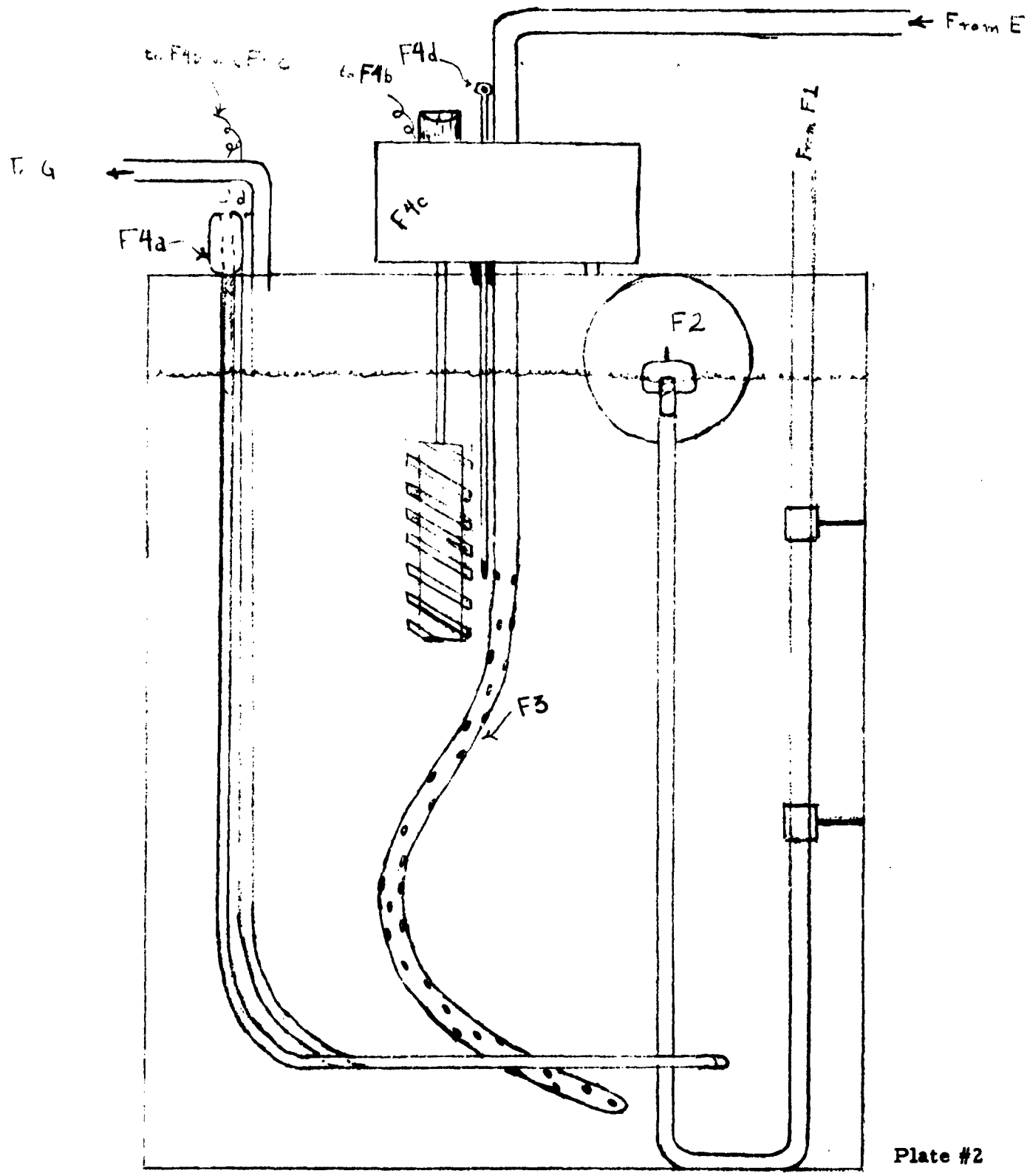
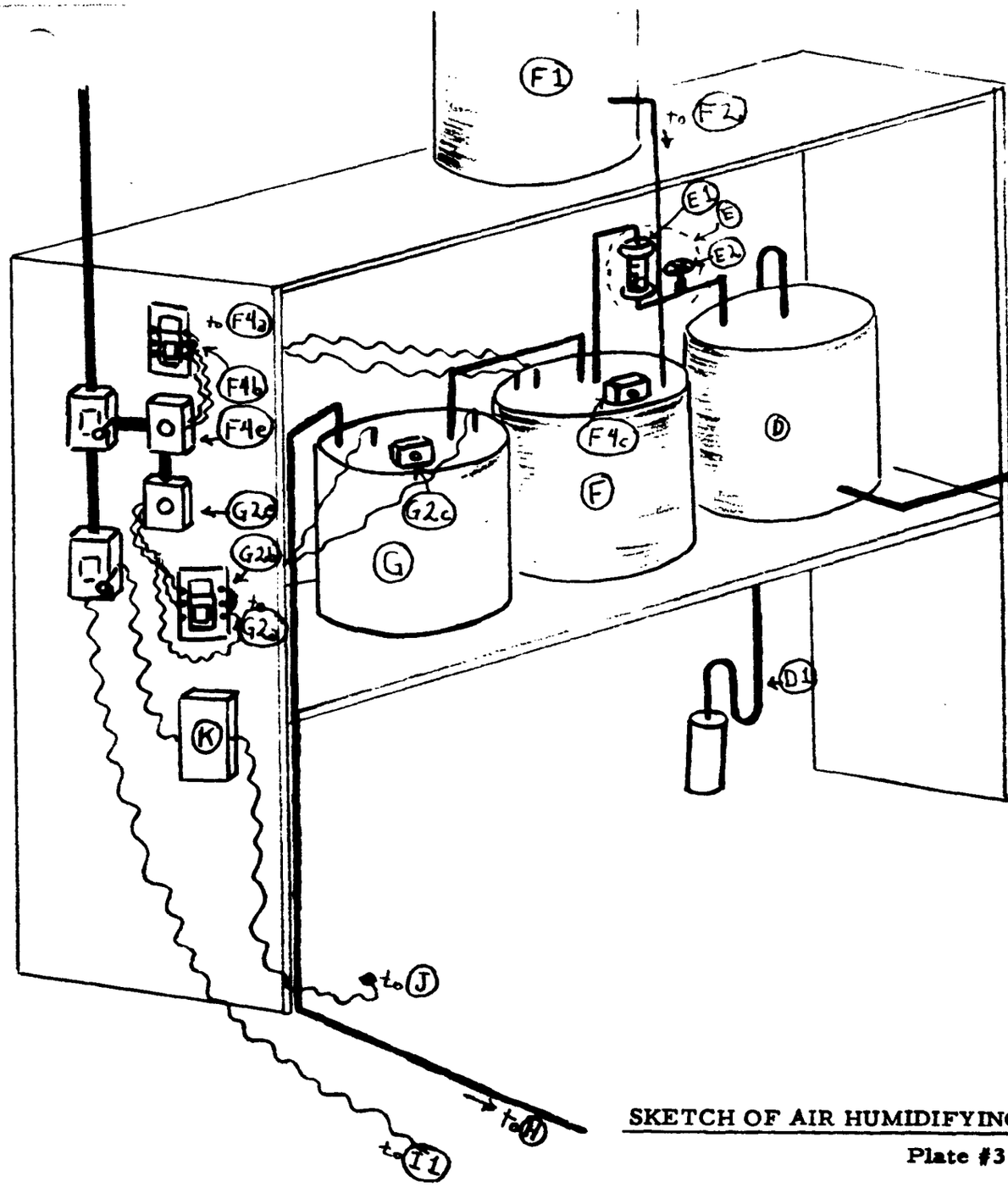


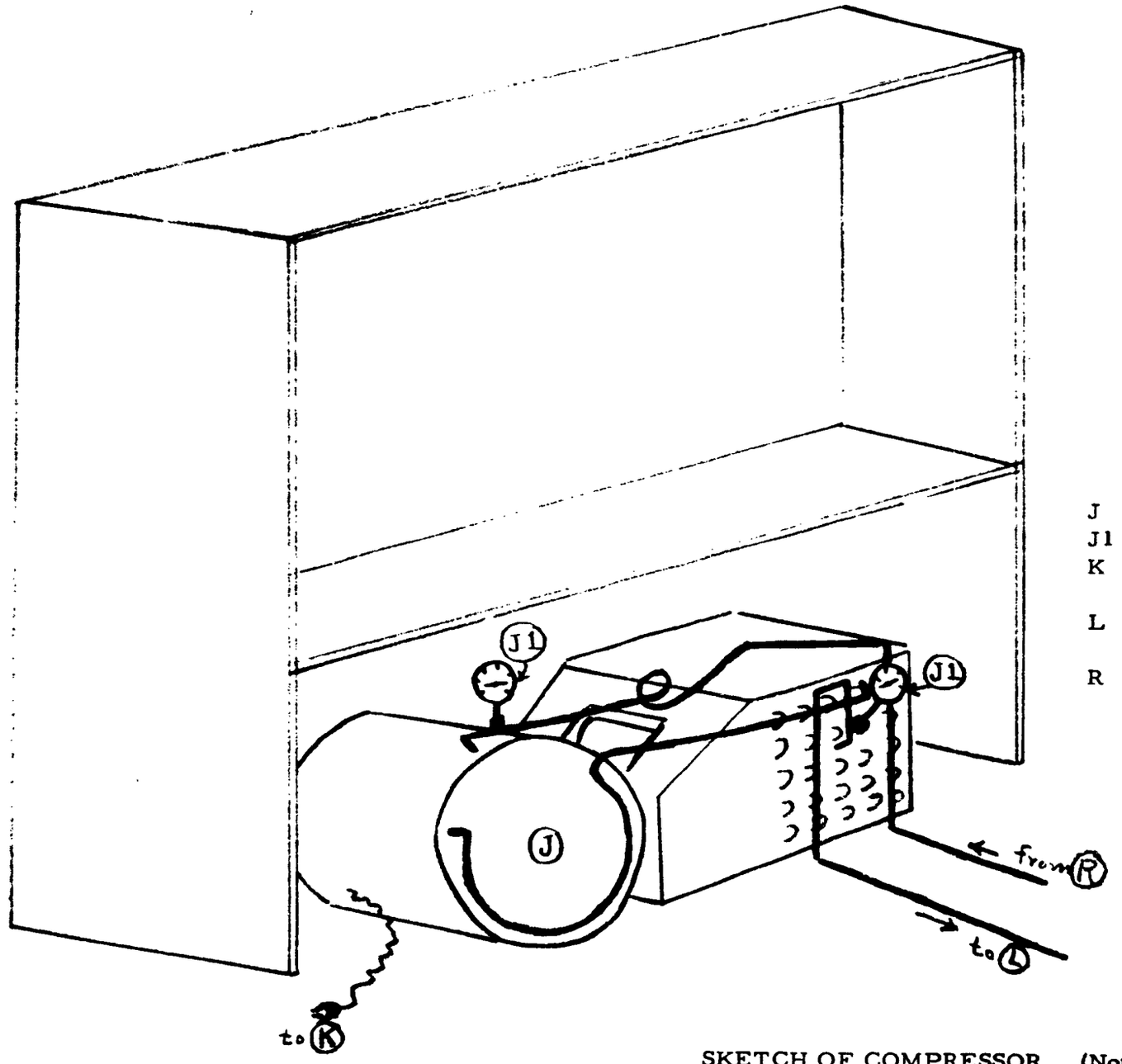
Plate #2



C	Pressure regulator (not shown)
D	Filter, Fiberglas
D1	Relief tube
E	Flowrater
E1	Flowmeter
E2	Needle valve
F	Moisture chamber
F1	Water tank
F2	Float valve (not shown)
F4a	Immersion heater (not shown)
F4b	Relay
F4c	Thermostat
F4e	Pilot light
G	Heat exchanger
G2a	Immersion heater (not shown)
G2b	Relay
G2c	Thermostat
G2e	Pilot light
H	Air distribution
I-1	Cabinet heating system (not shown)
J	Compressor (not shown)
K	Programmer

SKETCH OF AIR HUMIDIFYING SYSTEM (Not to Scale)

Plate #3

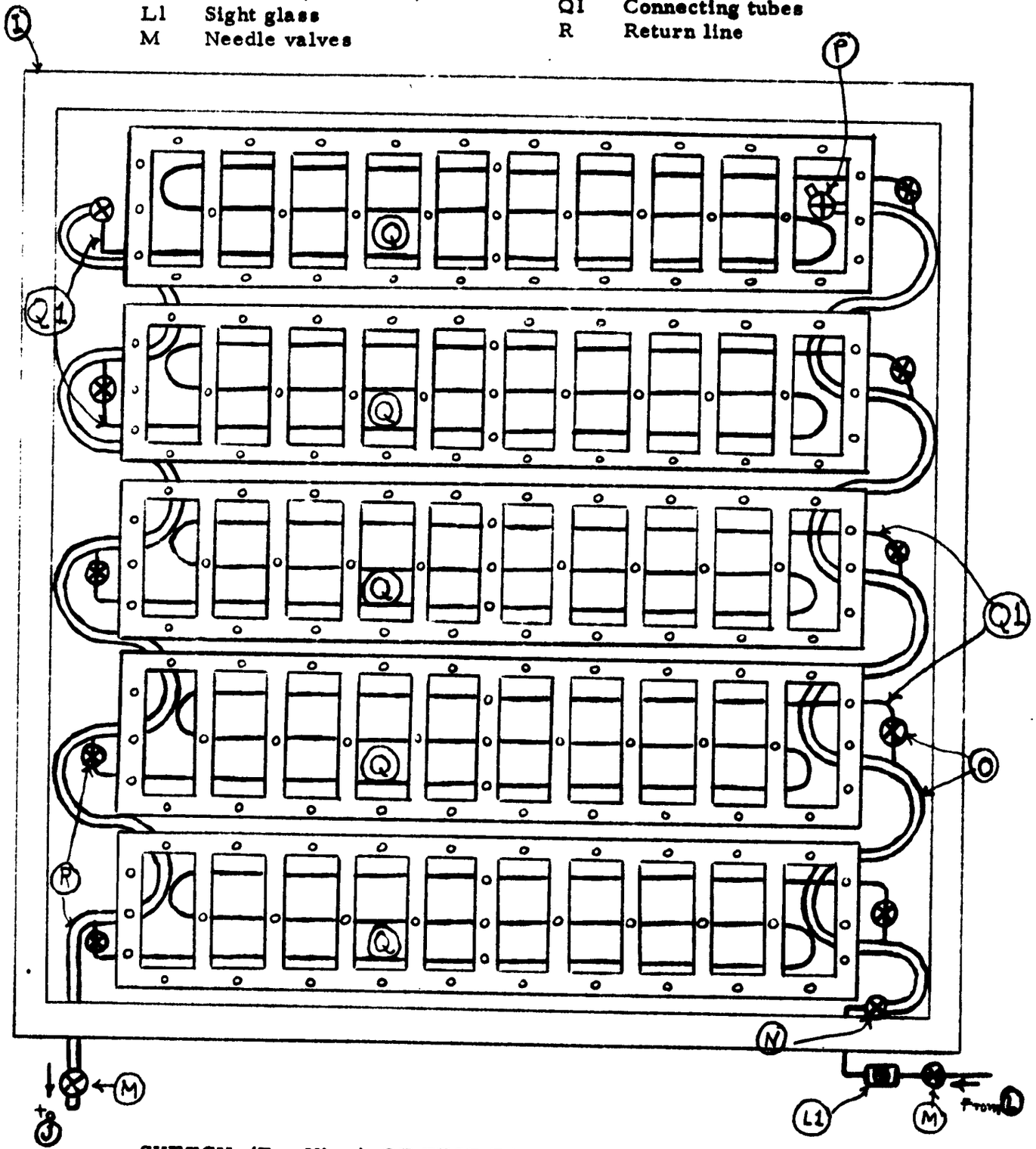


J Compressor
J1 Pressure gauges
K Programmer (not shown)
L Moisture filter (not shown)
R Return line (not shown)

SKETCH OF COMPRESSOR (Not to Scale)

Plate #4

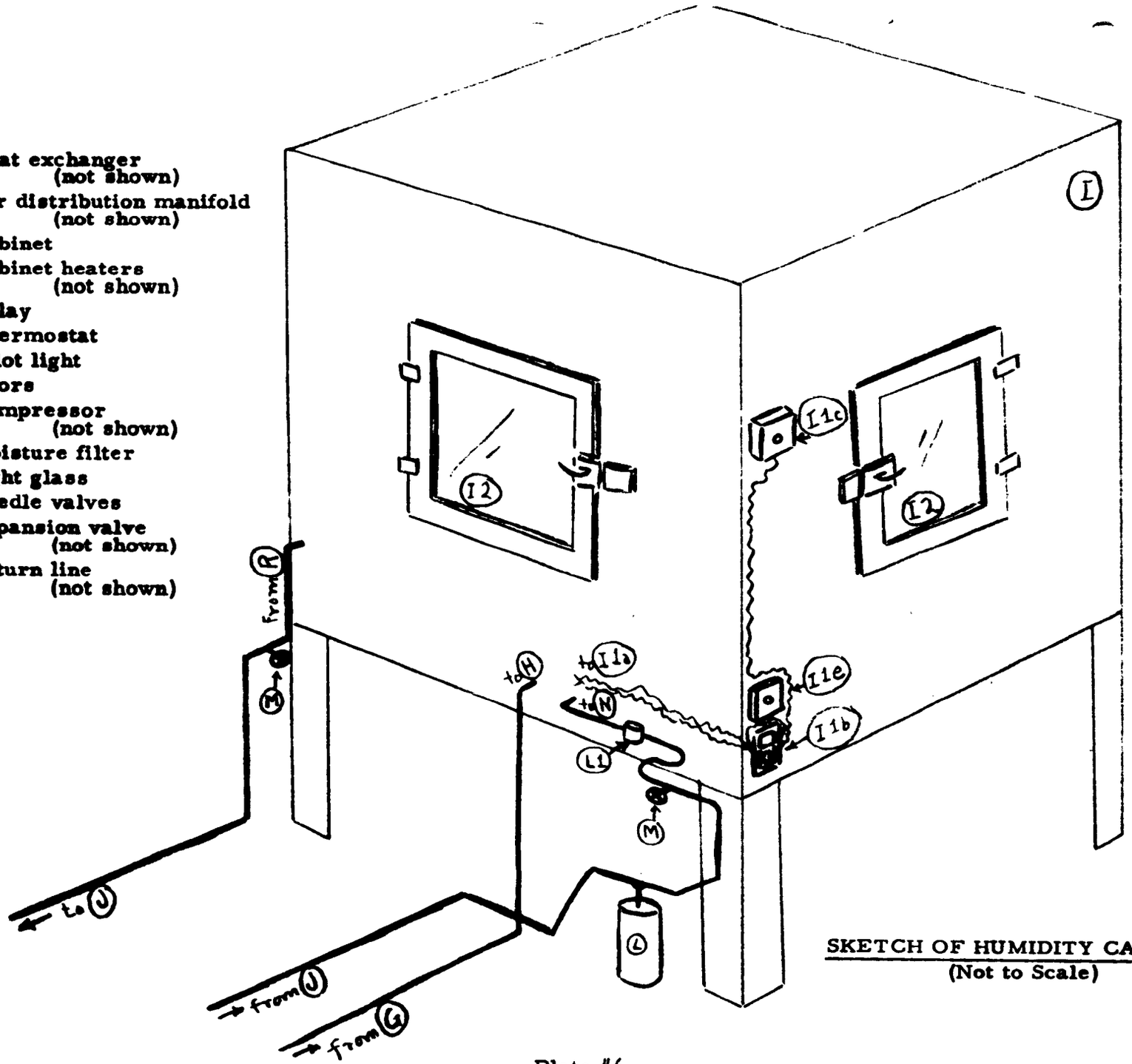
I	Humidity cabinet	N	Expansion valve
J	Compressor (not shown)	O	Manifold and T-valves
L	Moisture filler (not shown)	P	Bleeder
L1	Sight glass	Q	Specimen trays
M	Needle valves	Q1	Connecting tubes
		R	Return line



SKETCH (Top View) OF TEST PANEL MOUNTING (Not to Scale)

Plate #5

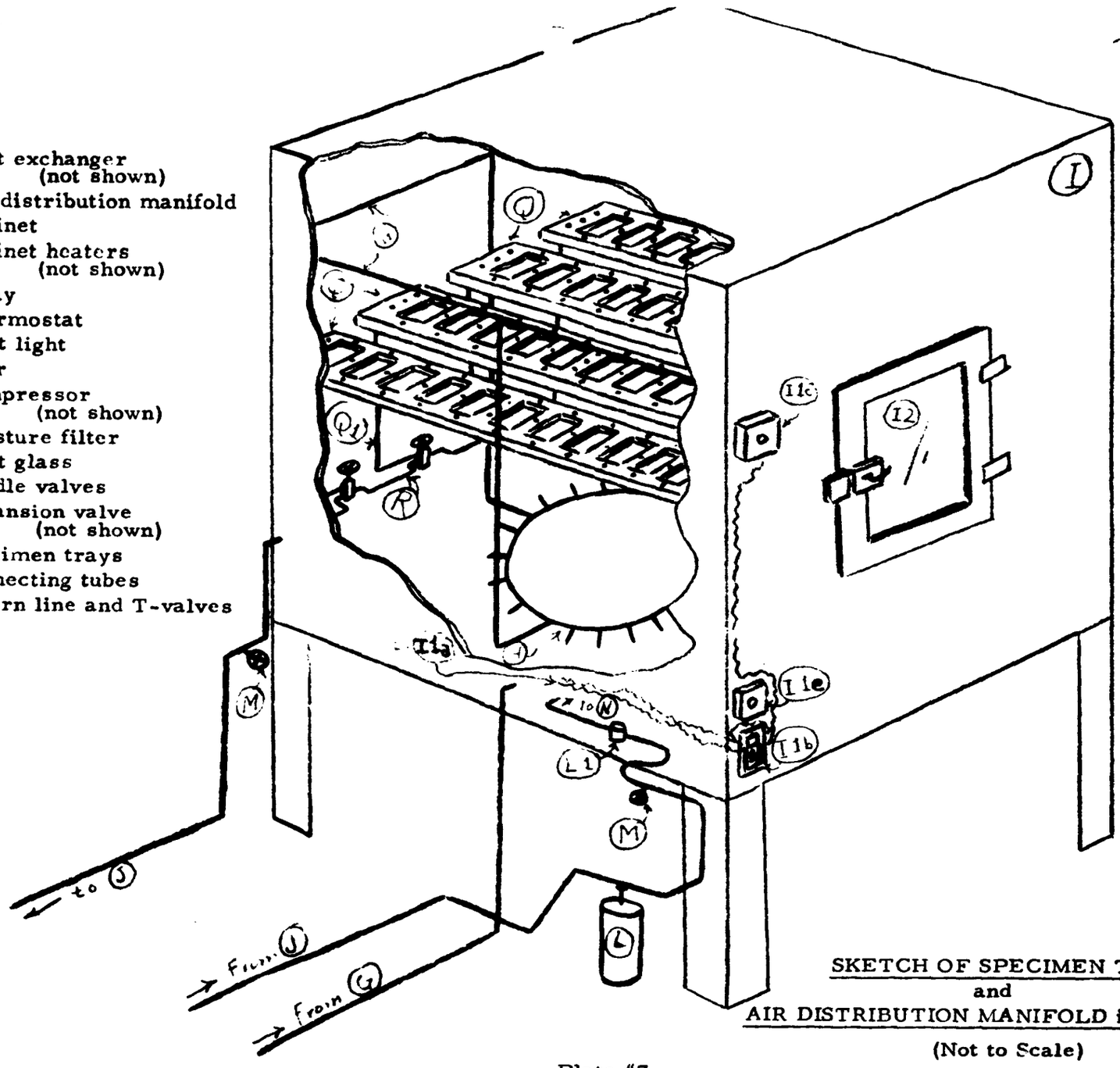
G	Heat exchanger (not shown)
H	Air distribution manifold (not shown)
I	Cabinet
I-1a	Cabinet heaters (not shown)
I-1b	Relay
I-1c	Thermostat
I-1e	Pilot light
I-2	Doors
J	Compressor (not shown)
L	Moisture filter
L1	Sight glass
M	Needle valves
N	Expansion valve (not shown)
R	Return line (not shown)



SKETCH OF HUMIDITY CABINET
(Not to Scale)

Plate #6

G	Heat exchanger (not shown)
H	Air distribution manifold
I	Cabinet
I-1a	Cabinet heaters (not shown)
I-1b	Relay
I-1c	Thermostat
I-1e	Pilot light
I-2	Door
J	Compressor (not shown)
L	Moisture filter
L1	Sight glass
M	Needle valves
N	Expansion valve (not shown)
Q	Specimen trays
Q1	Connecting tubes
R	Return line and T-valves



SKETCH OF SPECIMEN TRAYS
and
AIR DISTRIBUTION MANIFOLD in CABINET
(Not to Scale)

Plate #7